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AUTHOR(S):

NINDI, J. Stephen

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# CHANGING LIVELIHOODS AND THE ENVIRONMENT ALONG LAKE NYASA, TANZANIA

Stephen J. NINDI
*Centre for Sustainable Rural Development, Sokoine University of Agriculture*

ABSTRACT People living along the Lake Nyasa shore, Tanzania relies largely on fishing and cultivation of cassava and rice. The fishing industry has shaped the sociopolitical organisation of local people. The Matengo Highlands and Livingstone Mountains act as catchments of Lake Nyasa. The relationship between the land use in the catchments, Nyasa people's livelihood and the lake fishing environment is intriguing, because of the belief that catchment forests and streams help make the lake basin a rich habitat. However, recent microeconomic changes in the Matengo Highlands have subjected the catchment areas to undue deforestation from uncoordinated farming activities. The unprecedented degradation of the catchments has disrupted the fish ecology, hence dwindling livelihood opportunities. The local population has had to diversify livelihood strategies. This study examined the changing livelihoods and the environment along Lake Nyasa and mitigation that people have made in response to the changing fishing environment. Extensive surveys and farmer exchange visits were employed to collect diachronic information on livelihood and environmental dynamics along Lake Nyasa and in the Matengo Highlands. Farmers' exchange visits between the Nyasa and the Matengo allowed villagers to share insights and experiences in an attempt to establish mutual strategies for sustainable local resource management.

Key Words: Lake Nyasa; Catchments degradation; Livelihood diversifications; *Kumbi*; Farmers' exchange visit.

## BACKGROUND

### I. Overview of Lake Nyasa

Lake Nyasa, situated in the south-western part of the United Republic of Tanzania, is the ninth largest lake in the world and the third largest in Africa. Lake Nyasa is home to 15% of the world's freshwater fish species, with more than 600 endemic species in total (Chafota et al., 2005). The lake also lies within a flyway of migratory birds that feed along its shores on their route between Africa and Europe. The lake produces fish, which is a major source of animal protein for surrounding populations and nearby town centres. In addition, the daily survival and livelihoods of the Nyasa people depend largely on fish catches from the lake. The lake is shared by Tanzania, Malawi, and Mozambique. On the Tanzania side, numerous rivers such as the Kiwira, Ruhuhu, Lumeme, Ruekehi, Lwika, Mbamba Bay, Likumbo, and Chiwindi emerge from the Livingstone, Kipengere, and Uporoto Mountains and the Matengo Highlands to feed the lake and form the catchments that support aquatic life.

Land use along Lake Nyasa is typified by cultivation of miniature plots of cassava, paddy, groundnuts, and other minor crops. Mound cultivation is common for cassava and ground nuts, whereas flat seedbeds are used for cultivating paddy fields. The agriculture along Lake Nyasa is solely rain fed; extensive wetlands along the lakeshore have until the past two decades been intact, and the few wetlands under cultivation have been supported by rivers flowing from mountain catchment forests.

As is typical in most humid tropics, degradation of the catchments is common in the Livingstone Mountains and the Matengo Highlands, which are catchments of Lake Nyasa. Since the late 1980s, these catchments have been subjected to undue pressure primarily in the form of severe deforestation from extensive, uncoordinated farming activities. These activities have appreciably increased sedimentation in the rivers and the lake itself due to increased erosion, thereby disturbing aquatic biomes. As a result, fishing, the backbone of the local livelihood, has declined substantially. Unfortunately, because this deforestation coincided with the weakening of indigenous social organisations that supported fishing and promoted social stability, the future of the area and its fishing industry is in question.

Despite the significance of Lake Nyasa (i.e., due to its size, the presence of diverse fish species, and the livelihood it supports), the current situation is rarely acknowledged in academic circles or at the policy level, especially in Tanzania. The few studies that have been conducted, mainly on the Malawi side (Abdallah & Barton, 2003; Chafota et al., 2005), have concentrated largely on the identification of fish species. Dramatic declines in catch, especially in the southern part of the lake (Tweddle & Magasa, 1989; Donda & Bell, 1993; Turner et al., 1995; Banda et al., 1996), have been ascribed primarily to overfishing. The livelihood dynamics of the people residing along this lake, their social organisations, and the catchment–lake environment are under-researched due in part to (a) the lake's remoteness from major towns and cities; (b) the rugged landscape; and (c) the poor road conditions, especially during wet seasons. Yet there is a need to understand the dynamics of the people and environment that have retained this heritage despite such pressures. Examining the livelihood–environment problem in a wider context will aid in the formulation of appropriate interventions that are need-oriented, respectful of the indigenous nature of the area, ecologically sound, and participatory based.

This study focused on developing a methodology for studying rural development based on environmental conservation and livelihood diversification. It operated under the premise that the changing economic situation in modern Africa has put pressure on the natural and edaphic environments that influence people's livelihoods and their sociopolitical organisation. From this perspective, scientists from different disciplines must contribute to new understanding of the dynamic rural development, rural experiences, insights, and wisdom that are paramount in attaining sustainable rural development.

## II. Objective

The main objective of this study was to (a) examine diachronic trends of natural resource management and changing livelihoods along Lake Nyasa; and (b) investigate contributing factors, such as increased deforestation and ill-advised farming activities in the Livingstone Mountains and the Matengo Highlands, which serve as catchment areas of Lake Nyasa. More specifically, the study aimed to do the following; to investigate the influence of social organisation among the Nyasa and the Matengo on enhancing resource management, to examine contributing factors to changing livelihoods and environments along Lake Nyasa and in the catchment areas; to describe livelihood diversification and environmental management along Lake Nyasa; and to investigate the practicability of using farmer exchange visits to promote local resource management.

## III. Methodology

### 1. *Location of the Study Area and Biophysical Features*

This study was conducted in villages along the shores of Lake Nyasa, including Mbamba Bay, Chinula, Matenje, and Liuli on Tanzania side. Lake Nyasa is a large, long, and narrow freshwater lake in southern Africa covering the territories of Malawi, Mozambique, and Tanzania. It is the southernmost of the Western Rift Valley lakes (the most southerly of the Great African Rift Valley lakes), located between 9°30'–14°40'S and 33°50'–33°36'E.

Lake Nyasa (*nyasa* means "lake" in Nyanja) is the third largest lake in Africa after Lakes Victoria and Tanganyika and the third deepest freshwater

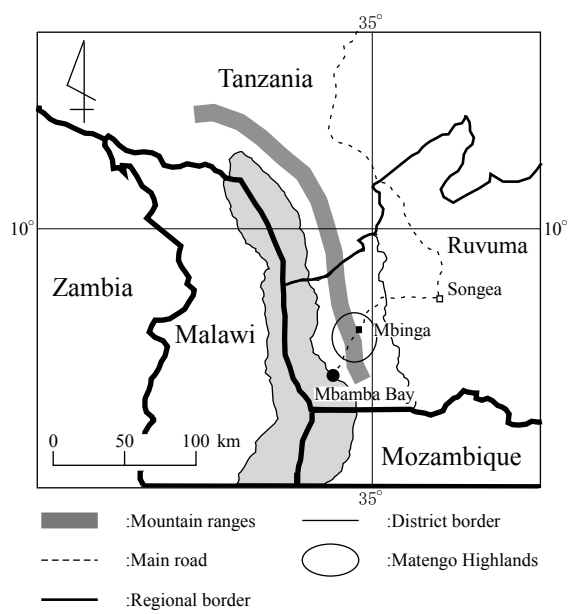


**Fig. 1.** Location of Lake Nyasa, Mbinga District, and the Matengo Highlands

lake on Earth, with a surface area of 31,000 km$^2$. The lake is known for being home to a greater variety of fish species than any other lake in the world, with the majority of those species being endemic (Ribbink et al., 1983). Due to its size and rich biodiversity, the lake is recognised as a global heritage site.

2. *Topography, Climate, and Drainage*

Lake Nyasa was formed millions of years ago as part of the development of the Great Rift Valley system of Africa. It is considered an ancient lake in global terms and is highly important biologically. The lake lies within the walls of mountain ranges delineated by faults, steep slopes, and deep shores in some isolated places. These mountain ranges include the forested Livingstone Mountains and the Nyika Plateau, which provide magnificent views of the lake. The lake depression consists of a series of grabens and half-grabens (blocks of the earth that have tilted and dropped during rifting), and its pattern of rift faulting has resulted in a varied landscape of extensive plains in the south and steep-sided mountains in the north. Near-shore topography varies between gently sloping beaches and steep, rocky coastline. Low altitudes (around 500 m above sea level) characterise the shores of Lake Nyasa on the Tanzania side. The climate is generally hot and humid along the shore (annual average temperature 30°C) and cooler in the highlands (Matengo Highlands, Livingstone, Uporoto, and Kipengere mountain ranges), reaching 8°C.

Although some of the plateau regions of the lake contain thick colluvial soils, the drainage basin is dominated by metamorphic and igneous gneiss, schist, and granite soils (Carter et al., 1973). The watershed along the research area is of a mixture of woodlands (*Brachystegia* spp.) and farmlands The lake catchment covers roughly 130,000 km$^2$ and includes much of Malawi, the south-western corner of Tanzania, and the north-western corner of Mozambique.

Fourteen major rivers pour their waters into the lake, but only one river, the Shire (on the Malawi side), flows out to sea. Thus, despite its large size, Lake Nyasa does not have a high volume of outflow. Of the approximately 68 km$^3$ of water that enter the lake annually, only about 16% flows out the Shire; the remainder evaporates directly from the lake surface (Bootsma et al., 1996; Bootsma et al., 2003). The dominance of precipitation and evaporation in the hydrologic cycle means that the lake is very susceptible to changes in climate.

3. *Ethnicity*

Three main ethnic groups occupy the lake on the Tanzania side. The Nyasa (Nyanja), consisting of the smaller groups; Mwela and Mpoto, occupy primarily the eastern part of the lake that extends to Mozambique. The Manda and Kisi dominate the northern part of the lake that extends to the Kyela District, Mbeya Region.

4. *Research Process*

I used an anthropological and extension approach that involved living in the rural community. Farmer exchange visits enabled villagers to share insights

and experiences on resource management that can lead to sustainable endogenous rural development. Three farmer exchange visits each took three days were arranged to share insights about community development projects: (a) The Nyasa people visited the village of Kindimba (in the Matengo Highlands), (b) the Nyasa visited the village of Kitanda (also in the Matengo Highlands), and (c) The Matengo farmers from Kindimba and Kitanda visited the Lake Nyasa. These visits were made between July and November 2005. This approach was based on my experiences with fieldwork in the Matengo Highlands and aimed to use people themselves to describe the reality of rural life from a multidimensional and interdisciplinary perspective. This approach to community and rural development falls under the 'alternative paradigm,' which seeks endogenous development based on the indigenous nature and uniqueness of each locale. Thus, it was necessary to apply anthropological and extension approaches to gain a wider and more integrated understanding of the relationship of the environment to people's changing livelihoods. This approach is not a panacea for answering all complex rural development questions, but it is worth using in a flexible way with respect to changing local conditions. It was important to involve the Matengo farmers in the exchange visits so they could experience the impact of their activities on other communities. The lessons learnt by the Matengo farmers helped the Lake Nyasa farmers gain insight into the impact of the research and underscored the rationale for participating in the study. The Matengo farmers are experienced in contacting and working with researchers and other development stakeholders and have implemented various projects related to community development and environmental management.

Data were also obtained by observation of catchments, river systems, wetland and fish catch volumes, and community activities while living in the study villages. Interviews with the Nyasa people in several villages, with district authority leaders as well as satellite image analysis, revealed diachronic trends in livelihood diversification and in the environment along Lake Nyasa and the Matengo Highlands.

An extensive field survey was conducted along Lake Nyasa and the Matengo Highlands in March, May, July, September, October, and November 2005. I spent the first 2 months living with families along the lake and in the Matengo Highlands while conducting surveys.

## PHYSIOCULTURAL SETTINGS ALONG LAKE NYASA

### I. Land Use and Livelihood

Fishing and agriculture dominate local livelihoods along the lake. Farmlands along Lake Nyasa are narrow and elongated. Agriculture is practiced largely for subsistence and is dominated by cassava farming and rice cultivation. Cassava, which is a staple crop in this area, is grown primarily in conical mounds,

whereas rice covers flat seedbeds of low-lying wetlands. Rice is produced mostly for selling and as a snack or food for special occasions such as weddings, funerals, and traditional dances. However, in the Mbamba Bay suburbs it is becoming increasingly more common in restaurants because the town is fast becoming a business centre. Farmers often use hand hoes and billhooks and application of chemical fertilisers and other agro-chemicals is unpopular. Landholding and tenure are characterised by smallholdings with isolated or dispersed farm plots of no more than 2 acres owned by a clan, family, or individual.

Fishing is largely done by men, whereas labouring on land is done by both men and women (although tedious farm activities are mostly performed by women). Petty trading in fish and agricultural products is common. In suburban Mbamba Bay women are highly involved in trading fish in the town of Mbinga; however, their trading volume is small. Men dominate large volume, distant fish trading, although most of the long-distance fish traders are not locals but are the Yao and the Bena peoples from other districts.

Typically, the Nyasa fish and sell their catch at the lakeshore to long-distance traders (the Yao and the Bena), who later transport it, mostly as dried fish and sardines, to distant markets such as the Mbinga and Songea town centres. Barter trading is still common among the Nyasa and in the neighbouring Matengo Highlands. The goods most often exchanged for fish include beans, finger millet, *chikande* (*Satyrium neglectum* Schltr. var. *neglectum*), and maize from the Matengo Highlands. On rare occasions, the Matengo exchange their products for dogs used mainly for hunting in the highlands. Fish trading among Nyasa communities is also common, especially with the increasing monetarisation of the rural economy and the breakdown of the traditional *kuombaliza* practice.[(1)]

## II. Sociopolitical Organisation of the Nyasa and the Matengo

The Nyasa are historically non-hierarchical Bantu people originating from a collection of sovereign patrilineal and matrilineal groups of equivalent status and diverse origins. Grandfathers (*bambo*) represent each patrilineal group, and uncles (*achibweni*) historically represented matrilineal groups. However, as a result of intermarriages or unknown reasons, the matrilineal factions have ceased to exist.

Before the *ujamaa* (African socialism) villagisation programme of the mid-1970s, the settlement pattern was characterised by collections of households of common ancestry within each hamlet. This led to the formation of *mudzi* (a small village), similar to *musi* in the Matengo Highlands (refer to *musi* and other sociopolitical organisations of the Matengo in the Miombo Woodland Agro-ecological Research Project [JICA & SUA, 1998]). The traditional *kumbi* organisational system controlled the *mudzi*.[(2)] Social order, norms, and values of the *mudzi* were managed by the *kumbi* social organisation (similar to the *sengu* in the Matengo Highlands) under the leadership of a male elder of the extended family.

Farm labour organisation takes primarily four forms: family, mutual aid (*chiyao*, similar to *ngokela* in the Matengo Highlands), informal (*chama*), and the recent farmer group (*kikundi*). *Chiyao* has always been accompanied by special food and drink signifying the generosity and hospitality typical of *ngokela* in the Matengo Highlands. *Chama* is maintained through loosely connected memberships and attached regulations. *Kikundi* is new and unpopular, a variation on *chama* is that the later (*chama*) largely evolved from extension services from farmers' field school which is promoted by International Fund for Agricultural Development (IFAD); it is a formal institutional approach.

## III. Sociopolitical Organisation and Customs along Lake Nyasa

Agriculture, fishing activities, and the fishing environment all shaped the sociopolitical organisation among the Nyasa people. Descendants of the same ancestor, under the leadership of a male elder, would come together along the shoreline and build a small hut known as a *kumbi*, which was used by men primarily for discussion about the social welfare of the extended family while waiting for those who had gone fishing. Various family activities occurred at the *kumbi*, including social teachings for younger generations and the handling of extended family matters. It was the responsibility of *kumbi* elders to scrutinise, arrange, or decide land plot allocation, farming activities, land dispute settlements, marriages, and the like. In the case of interlineage dilemmas such as shortages of rain, occurrence of unusual disease or death, or collective juvenile delinquency, elders of various *kumbi* would meet, normally at night, for discussion and action. Similarly, inter-*kumbi* (larger community) rituals were organised by elders of various kumbi, even those from different villages. Elders of the *kumbi* also organised social functions, such as traditional dances.

Various functions of the *kumbi*, except for the most critical or secret ones, were normally performed while people were waiting for those who had gone fishing. Once the men returned from fishing, all people gathered at the *kumbi* (except for the elders of the *kumbi* and their friends of similar high social cadre) would join together to pull the canoes off the water and to organise the fishing nets. Fish were first distributed to those who had fished that day, then to elders of high standing, and later to others free of charge depending on the volume of the catch. Children were not forgotten; fish were thrown into the air, and the children would compete to catch the fish as they fell to the ground. This system of fish distribution undermined selfish ambitions and emphasised cooperation and shared progress is what was known as *kuombaliza*. It was also not uncommon for elders of high standing to receive fish before the general distribution could begin. Sometimes these elders would not wait to achieve *kuombaliza*; rather, they had the power and social respect to collect their fish without compromising the opportunity for the other individuals to obtain theirs. It was rumoured that if a person denied distinguished elders the chance to collect the fish they needed, there would be no more catch until a ritual (*kupema*) was performed. Thus, fear of witchcraft maintained the social organisation in the area.

While men gathered at the *kumbi*, the women remained at home performing household activities and teaching girls to take on maternal roles. Because women were not directly involved in fishing activities, fishermen would take fish to widows and other helpless people to sustain them. It was not unusual for both men and women to send fish as a gift to friends and relatives who lived in distant villages. This was always done in a reciprocal way.

It was the responsibility of the *kumbi* elders to conduct rituals related to declining fish catches or to calm the devastating lake tides (*mwela*). Herbs (*mbatawata*) soaked in clay pots (*mbiya*) were commonly used in *kupema*.[3] To gain collective power in rituals, *kumbi* elders sometimes consulted women who were known to have spiritual power or practice witchcraft. Because such women were also suspected of using witchcraft to induce high tides or hide fish, they often had to be persuaded to help the *kumbi* elders. It was believed that such powerful women could hide fish or influence high tides if fishermen did not send them fish. These women used witchcraft to influence their recognition in a male-monopolised council *kumbi*. When fish catches continued to decrease or mysterious events haunted the community and rituals were of no help, elders of various *kumbi* would join together and appoint representatives who travelled to neighbouring countries to bring back witchdoctors (*chikanga*) to unveil the secret behind the mischief in the village(s).

Another salient feature of the traditional social organisation along Lake Nyasa was the giving of food crops (*matola*) as gifts among female friends, which was a symbol of reciprocity, cooperation, prestige, and shared progress during the *kumbi* era. After the crop harvest, women sent full buckets of rice, cassava, or cassava flour to their close friends, more often than not escorted by other village women. The host would prepare a special food (usually chicken or goat served with rice or thick maize porridge [*ugali*]). In the next season, the generosity would be reciprocated to the donor. Such friends helped one another in many other activities, ranging from farming to ceremonies.

Traditional dances, *kioda* for women and *mganda* for men, fostered strong social cohesion among the lake communities and even the adjacent mountain dwellers. These dances were performed after the crop harvest and when fish were available. Dance groups (*boma*) from nearby or distant villages would be invited to a host village, and dancers would stay in host houses for 2 to 3 days eating, drinking, and dancing together. Many friends were made in this way and ties remained strong; even today, one person may call another "my relative" even though their bond is a deep-rooted friendship rather than blood. Thus, traditional dances enhanced social networks and unity in this area.

The *kumbi* social organisation lasted only until the mid-1970s, when the Tanzanian government enacted the villagisation programme. The villagisation programme disrupted this stable and deep-rooted social organisation by displacing descendants of the same ancestors to distant localities isolated from the lakeshore where they could not form *kumbi*. Elders lost their ritual performing power to new and inexperienced formal village organisational leaders. Villages along Lake Nyasa were among those most strongly hit by the villagisation pro-

gramme (possibly because they had no strong cash crops), as was as the case with their neighbours in the Matengo Highlands. As *kumbi* collapsed, *kuombaliza* and *kupema* also began to decline, and by the late 1980s, with the monetarisation of the rural economy, these systems were effectively crushed. Currently, with the declining fish catch, *kuombaliza* remains little more than a story to tell younger generations, and *kupema* is kept within each household. However, *matola* has persisted, although on a smaller scale, possibly because it has little influence on male-dominated *kumbi* politics.

## LIVELIHOOD AND ENVIRONMENTAL DYNAMICS ALONG LAKE NYASA

### I. Perspectives of Livelihood and Environmental Dynamics

Until the 1970s, fishing activities dominated the livelihoods of the people along Lake Nyasa. *Kuombaliza* shaped the fish gift giving that maintained social organisation under *kumbi* leadership. However, by the late 1970s and early 1980s, decline in fish catches were in the spotlight. In their interviews, people associated this situation with multiple factors ranging from environmental degradation in the catchment areas to overfishing to the breakdown of social organisation after the villagisation programme, which, through rituals, maintained fishing practices in the lake.

Coincident with the villagisation programme, the Matengo farmers in the upland catchment area accessed large quantities of highly subsidised agro-chemicals for maize and coffee farming through the National Maize Programme. Application of such agro-chemicals to steep slopes possibly led to the seepage of chemicals into the rivers that opened into Lake Nyasa, a situation that destroyed aquatic life in the rivers as well as along the lakeshore. People reported that it was at this time that villagers began to notice an unprecedented number of fish deaths along rivers and the lakeshore, possibly because the lives of fish in Lake Nyasa are closely related to the stability of the catchment and the river systems. The villagisation programme of the mid-1970s also led to an unnecessary concentration of people along Lake Nyasa, which created a land shortage and led to the use of undisturbed wetlands (*makata*). Over cultivation of such wetlands evoked appreciable sediment trafficking into the lake, and fish ecology, especially breeding zones along the rivers and near shore, was greatly disturbed. The result may have been fish migration or impaired breeding cycles, both of which would have decreased fish availability and species diversity.

Another factor that led to changing land use in the highlands was the economic destabilisation faced by the Matengo since the mid-1990s, especially after the collapse of the Mbinga Cooperative Union after the liberalisation of the coffee market (Nindi, 2004; Mhando, 2005). Collapse of the Mbinga Cooperative Union negatively impacted the ability of the Matengo farmers to access chemical fertilisers to support production in their discrete mountain farm plots. This

led to the creation of new farms on virgin land in adjacent areas where the use of agro-chemicals was not necessary. The Mount Livingstone catchment area was not spared by this invasion. Unfortunately, most farmers who moved to Mount Livingstone were from the Hagati Plateau in the Matengo Highlands, an area that normally conducted ridge cultivation. Cultivating ridges on such steep and rugged slopes provoked intensive soil erosion and sediment runoff to river valleys and, consequently, to the lake itself. Based on Kjekshus (1977), Pratt & Gwynne (1978), and Pomeroy & Service (1986), Itani (1998) argued that soil erosion from agricultural practices is a serious problem in mountainous areas that experience frequent heavy rains. In such environments, the removal of vegetation can easily erode surface soil; if the land is cultivated, erosion becomes more serious and the land may become barren within several years.

Satellite image analysis results presented in Table 1 show the changing water levels in Lake Nyasa due to increasing sedimentation. The table also shows the extent of changing vegetation cover in the catchment areas.

In discussions, people lamented the fact that uncoordinated and rapid deforestation of Mount Livingstone led to changed river regimes, increased flooding and lake sedimentation, destroyed aquatic biomes, and further deterioration of the livelihoods and physical environment of the people residing along Lake Nyasa.

During the survey, locals stated that various rivers (e.g., the Mbamba Bay, Lwika, Maliwa, Lumeme, Luekehi, and Likumbo) had changed from perennial to seasonal rivers, that their sizes and water volumes had significantly shrunk, or that their flow directions had changed greatly since the late 1980s. They mentioned that a large iron bridge over Luekehi River at Tembwe near the lake had shifted to Nangombo (about 5 km away) due to torrential flooding in the mid-1990s. This flooding had broken the former bridge, turning the river into three streams and leading to more government expense. It also necessitated shifting the road that connected Mbamba Bay and other villages along the way to the Mozambique border. The Mbamba Bay River bridge, which was made of iron bars, is now overrun by culverts due to the reduced river volume caused by increased sedimentation.

Similarly, the strip of the Lake Nyasa shore that extends from Liuli to Chiwindi (on the border with Mozambique) has undergone an increase in popu-

Table 1. Changing Water Levels in Lake Nyasa and Land Use Changes in the Mount Livingstone Catchment Area (%)

| Periods | Deep water (Lake Nyasa) | Shallow water (Lake Nyasa) | Forest | Open forest | Shrubs | Grassland/ scattered trees | Cultivated fields |
|---|---|---|---|---|---|---|---|
| 1984 | 41.13 | 2.83 | 16.96 | 10.62 | 11.47 | 13.82 | 3.15 |
| 1994 | 23.54 | 20.39 | 9.84 | 10.97 | 16.63 | 14.31 | 4.31 |
| 2000 | 24.09 | 20.11 | 8.16 | 10.70 | 14.92 | 15.29 | 6.73 |

Source: Own data extracted from satellite images

lation, and deforestation of the upper catchment is rampant due to influx of the Matengo farmers. The increased population relies directly on subsistence agriculture for food. The high population density along the lakeshore and in the catchments has resulted in the expansion of subsistence agriculture to marginal lands, including wetlands and steep hill slopes. The Matengo Highlands are one of the most densely populated areas in the Mbinga District, with approximately 100–120 people/km$^2$ compared to the estimated district density of 34 people/km$^2$ (DALDO, 2001). Associated impacts of the burgeoning human population coupled with uncoordinated macro- and micro-economic support systems are unsustainable agricultural practices and deforestation.

## II. Implications of Catchment Degradation for River–Lake Ecosystems and Livelihoods

With increased degradation of the catchments, flooding could become common and destructive for a lake with a high degree of precipitation/evaporation in its hydrological cycle. Kidd et al. (1999) reported that a small increase in precipitation/evaporation could result in flooding such as occurred in 1979/1980 in Lake Nyasa; a small decrease in this ratio could result in the basin becoming closed with no outflow, as was the case in 1915 and 1937. In recent years, the water level of Lake Nyasa has been declining (Table 1). According to Kidd (1983), approximately 25% of the lake catchment is within Tanzania; however, land use within Tanzania may have a disproportionate effect on the lake, because annual rainfall (and therefore river input) is greater at the northern end of the lake. Kidd (1983) contended that approximately 20% of annual river inflow to the lake comes from the Ruhuhu River in Tanzania. Historic data on river regime dynamics are very sparse, and the earliest measurements of atmospheric nutrient deposition were made in 1990/1991 (Bootsma et al., 1996). Thus, the monitoring of rivers and atmospheric inputs would provide a more sensitive analysis of temporal change. Nevertheless, historic limnological data suggest that the lake may be responding to changes in land use within its catchment (Bootsma et al., 1996).

Changes in land use in catchment areas not only affect erosion and nutrient inputs to the lake, they also appear to have a significant effect on hydrology within the catchment. A review of historic data of Lake Nyasa water levels, rainfall records, and land use change by Calder et al. (1995) indicated that between 1967 and 1990, forest cover in the Lake Nyasa catchment decreased from 64% to 51%. This loss of forest resulted in increased water input to the lake due to a decrease in terrestrial evapotranspiration rates. As a result, lake levels in the early 1990s were approximately 1 m higher than they would have been had this deforestation not occurred. The implications for terrestrial systems and for streams and rivers are likely negative, because stream flow tends to be less stable in deforested catchments.

It is likely that deforestation of the catchments and increased pollution influenced the decline in fish catches in the rivers and in the lake itself. This

may be a result of the coexisting lake–river relationship, which has negatively impacted the livelihoods of people living along the lake. Turner (2004) reported that some fish, such as *Opsaridium microlepis* (*mpasa*) and *O. microcephalus* (*sanyika*), have a tendency to migrate from lakes into rivers to spawn in gravel beds, although some members of the latter species may also spawn in lakes. Other species, such as *O. tweddlorum*, live in rivers throughout their lives. *Opsaridium* species within the Lake Nyasa catchment are heavily exploited on spawning runs into rivers and may also be affected by erosion of the river catchment due to poor agricultural practices that have led to flash floods and siltation of spawning grounds.

*Labeo mesops* (*nchila*), a large silvery fish that favours open sandy beaches, may also have been affected by this degradation. During the 1940s, this species supported the second largest fishery on the lake after Oreochromis species (Lowe, 1952). Its population has declined dramatically, and it is now quite rare in Lake Nyasa, likely due to degradation of the river systems where it once spawned (Turner, 2004; Snoeks, 2004). *L. cylindricus* (*ningwi*) favours rocky shores, where it competes aggressively with the mbuna cichlids for territories and food (algae). Although still abundant in some places, some local population declines have been noted. It seems that some species, such as *Synodontis*, breed in river floodplains but spend most of their lives in the lake; thus, their disappearance could be linked to river degradation. The disappearance of small sucker mouth catfish (*chimbumbu*: not identified), which are adapted to fast-flowing rivers and are rarely seen in the main lake, is evidence of the relationship of fish species disappearance to river degradation. Other fish species that might be disappearing as a result of lake and river degradation include *Clarias gariepinus* and *Mascusensis livingstoneii*, which also spawn in rivers and floodplains or in shallow weedy areas (Eccles, 1992).

Degradation of lake edges may also have disrupted populations of *Aplocheilichythys johnstonnii* (tiny lampeye killifish), which are found in sheltered weedy areas around the edge of the lake (Snoeks, 2004). The most conspicuous characin species is *Brycinus imberi*, which is a widespread riverine species; like many non-cichlids, it breeds in rivers. Turner (2004) argued that many non-cichlids of Lake Nyasa spawn within rivers and are particularly vulnerable to overfishing during spawning runs and to alterations of the river regime flows, which can lead to flash of floods and siltation of eggs. These factors have also likely led to declines in the populations of larger migratory species such as *Labeo* sp. (*chambo*) and *Opsaridium* spp. (e.g., *mpasa*). This corroborates formal and informal discussions in which informants revealed that some fish species abundant up through the 1970s, such as *chimbumbu*, *ningwi*, *kuyu*, *mpasa*, and *sanyika*, had disappeared. Bootsma et al. (2003) reported that the degradation of lake and river systems has supported the presence of the potentially toxic algae *Cylindrospermopsis raciborski*, which could affect zooplankton and fish production. For instance, in October 1999 a massive fish kill occurred along the western shore of the lake (the Malawi side), and toxic algae were one possible cause of this kill.

An indication of the extent of the lake erosion was provided by a comparison of the concentration of dissolved organic carbon (DOC) and particulate organic carbon (POC) in tributary rivers. In undisturbed rivers, the DOC concentration is generally about 10 times higher than the POC concentration. In contrast, in many Lake Nyasa tributaries, the POC concentration is much higher than the DOC concentration (Ramlal et al., 2003), suggesting exceptionally high erosion rates within the catchment. Not only do these erosion rates result in accelerated nutrient inputs to the lake, but the high-suspended sediment loads in rivers increase the turbidity of near-shore waters. Data collected by Duponchelle et al. (2000) indicated that greater turbidity led to decreased body conditions of rock-dwelling cichlids in Lake Nyasa, and the work of Seehausen et al. (1997) on Lake Victoria showed that increased turbidity can lead to a loss of biodiversity among cichlids.

In addition to catchment erosion, one challenge is the large proportion of atmospheric nitrogen and phosphorus entering Lake Nyasa. Although there are no historic data against which recent measurements may be compared, a global comparison indicated that atmospheric deposition rates of nitrogen and phosphorus in the Lake Nyasa region are among the highest in the published literature (Bootsma et al., 1996). There are several possible causes of these high deposition rates, including large amounts of biomass burning (largely from slash-and-burn agriculture in the Matengo Highlands and on Mount Livingstone) that occurs in this part of Africa as suggested by Andreae (1993), and the increased exposure of soil to wind erosion promoted by burning and deforestation though elsewhere can also be influenced by overgrazing.

Another factor in environmental degradation is the water hyacinth (*Eichornia crassipes*). This weed is now present in the lake and in many of its tributaries. Although this plant is not currently abundant within the lake, likely due to low nutrient concentrations, it has the potential to become a problem in the lake if nutrient inputs increase. This may have serious implications for biodiversity, as the lake's richest fish communities are found in the near-shore zone. Currently, most of the water hyacinths originate in tributaries and die in the lake; however, within the tributaries, water hyacinths are abundant.

Continued increases in fishing pressure, along with changes in plankton community structures and water quality due to lake sedimentation, may lead to a decline in biodiversity or even species losses if preventive action is not taken. Sediment core data and historic phytoplankton data (Hecky et al., 1999) suggest that nutrient inputs to the lake may be increasing, and this may cause changes in phytoplankton species composition. Total fish catch is difficult to estimate due to the large number of uncoordinated small-scale fishermen and the limited capacity of the government to collect sufficient catch data. Thompson (1995) estimated that on Malawi side, the total annual catch was approximately 30,000 tonnes, whereas Lewis & Tweddle (1990) estimated that the annual catch of one species alone, *Engraulicyppris sardella* (*usipa*), may have exceeded 50,000 tonnes. The majority of the artisanal fishery yield is made of *Copadichromis* spp. (*utaka*), *usipa*, and *Lethrinops species* (*chisawasawa*). Populations of numer-

ous economically valuable fishes have declined dramatically in Lake Nyasa, especially in the southern arms of the lake where fish catches have historically been the greatest. Yields of catfish (*Bagrus* and *Bathyclarias* spp.), *Opsaridium microlepis* (*mpasa*), *Labeo mesops* and *L. cylindricus* (*nchila*), and *Oreochromis* spp. (e.g., *chambo*) have decreased and currently make up less than 20% of the total catch (resulting in declining fish consumption; FAO, 1993; Turner, 1995; Irvine et al., 2002). In Malawi, for instance, fish consumption has declined from 14 kg per person per year in the 1970s to less than 6 kg per person per year (State of Malawi, 2002). Although the diversity of pelagic cichlid species in the near-shore communities is high by any standards (Ribbink et al., 1983), it is logical to assume that with increased degradation of the catchments and pollution of the lakeshores, the biodiversity of such species is also in danger.

People living along the lakeshore pointed out that populations of large animals such as crocodiles and hippopotami have also disappeared or remained in very limited areas after the degradation of their natural habitat along rivers. This situation has denied the lakeshore communities both heritage and tourist attractions and has brought poverty to thousands of households along Lake Nyasa. Most of these animals have migrated to Mozambique, where the catchment is intact to a greater extent and the river ecology is more favourable.

These factors have all contributed to the destruction of both livelihoods and the environment along Lake Nyasa, whose revitalisation and management requires a multidisciplinary approach. Based on these trends, the major threats to the Lake Nyasa ecosystem are the degradation of the catchment areas and suboptimal agricultural practices, which have caused destruction of the river systems and lake through sedimentation. Following the collapse of their main livelihood (fishing), people living along the lake have had to find alternative means of survival. Livelihood diversification has included changing their eating habits and altering fishing and agricultural activities.

## III. Livelihood Diversification and Environmental Conservation

Due to the declining fish catch and the inability to buy "good" fish (such as *chambo*, *mbufu*, *sanyika*, *kampango*, and *mpasa*), elders now eat inferior fish species such as *chidongo* and *nkoolokolo*, which in former times they would not have considered. These changing eating habits may prevent elders from insufficient protein consumption. Off-shore fishing has also become inevitable, as fishing near shore has proved futile. Whereas some men try fishing in deep waters, others must travel up to less degraded shorelines of the neighbouring country, Mozambique. Both fishing styles and fishnets are changing. The *gonga* fish net is replacing the old style *chilimila*, and the government has prohibited the use of small nets to conserve biodiversity in the lake. After the breakdown of *kuombaliza*, the fish–money relationship between fishermen and those who gather at the shore has dominated. Women's involvement in fish trading has increased despite smaller trading volumes; women no longer wait for fish at home but interact with men buying fish on shore.

Some people, especially those in Mbamba Bay and Liuli, are involved in the commissioned trading of ornamental fish, which targets near-shore cichlids primarily in rocky habitats. There is not yet enough information to determine the impact of this trade on local livelihoods. The decline in fish has also changed the dancing tradition; at present, the traditional dances (*kioda* and *mganda*) involve mostly nearby groups whose members dance and return home on the same day, no longer requiring the host to prepare special food and drinks for the guest friends.

The use of former wetlands (*makata*) for rice cultivation and dry-season gardening has increased, although the farm size per household has remained small. This is due in part to increasing market demand for rice and produce such as tomatoes, onions, Chinese cabbage, *Amaranthus* spp., mangoes, coconut, and sugarcane. Although the cultivation of otherwise intact wetlands and gardening very close to riverbanks ensure food security and income in the short term, they have long-term environmental implications such as further drying up of the wetlands, degradation of riverbanks, and sedimentation of the lake. Cassava and cassava flour are currently highly traded farm products, and finger millet farming is gaining in popularity, especially in villages on the slopes of Mount Livingstone.

Keeping pigs to sell or as security is now common in most households as a livelihood diversification strategy. Although pigs are kept indoors in most parts of Tanzania, along Lake Nyasa they are tethered or free to graze. Local breweries, which in former days operated free of charge, have also become monetarised, and women are highly involved in this business. The brewing and selling calendar is carefully scrutinised by revenue collectors appointed by the village government. The establishment of a market day, small shops and kiosks, and bicycle rentals in village centres are also among the new developments in the area. Youth from different parts of the country dominate these activities, possibly because their dynamic nature includes travelling and physical fitness. Recent famines in bordering countries have attracted appreciable export trading of cereals (maize and beans) and cassava from Tanzania. Although the Nyasa people are not big food exporters, their youth can earn money by working as guards, porters, or crop collectors at various supply points.

The function of the local government and the church has also been important in trying to diversify people's livelihoods. The popular Anglican Church and the Mbinga District council have both engaged in irrigation projects for rice production in some wetland areas along Lake Nyasa. The success of these two projects will help to improve income and food security. People living along the lake have also diversified their labour organisations, introducing new systems while maintaining the old. For instance, church choir groups have surfaced as another form of labour. Besides fulfilling church obligations, choir members help one another in various farm activities. Thus, the community is working together to realise the stability of both its spirituality and its livelihood.

Despite such diversification, the livelihood, social organisation, and environment along Lake Nyasa are still at a crossroads. What is needed is a partici-

patory and collaborative approach that recognises the indigenous nature of the people and the focal features of the area.

## FARMER EXCHANGE VISITS

After extensive fieldwork and a review of comments made by farmers from montane and lowland areas, it became imperative to involve both communities, the Nyasa and the Matengo in charting out collaborative strategies for the sustainable management of their common resources. This necessitated conducting farmer exchange visits. The participation of Matengo farmers was essential, as their mountain farming activities were to a large extent responsible for the current debilitating state of the Lake Nyasa catchment environment. The degradation of the Matengo highlands and its negative impact on aquatic life in bordering lowland areas strongly mirrored the experiences of the Kesennuma in Japan, where degradation of mountain environments impacted negatively on oyster farming in adjacent bay (Hatakeyama, 2003). The critical experience of the Kesennuma was that "the ocean and forests are linked by rivers, hence, we must think of a river basin and the neighbouring sea/lake as part of a single ecosystem." Indeed, forests and streams are important in making the lake a rich habitat for different species. Thus, it was important to invite mountain dwellers whose activities were linked to the lake to participate in the process and to personally discover the implications of their activities for the lake and river regime. Mutual participation between the two communities in the conservation of the catchment areas, where the river begins, will help plant the idea of environmental conservation in the minds of the people who live in the river basin. If both groups do not work together, success cannot be realised. Interaction between people living in the highlands and those on the coast would make both sides realise the need to work together to protect the forest, the river, and the lake environment, similar to Kesennuma case in Japan.

Another potential benefit for participating mountain farmers was that the Matengo social organisation and traditions resembled those of Lake Nyasa. The reciprocal labour organisation in Matengo, *ngokela*, is analogous to the *chiyao* along Lake Nyasa; *musi* is similar to *mudzi*, and *sengu* is akin to *kumbi*. Both ethnic groups also participate in *kioda* (for women) and *mganda* (for men). In both areas, gift giving (*matola*) among women is a common feature that reinforces hospitality. Their rituals, ceremonies, and even some elements of their languages are similar to an appreciable extent, which could have been a result of the influence of the Ngoni invasion in both areas in the 19th century. Such a situation underscores areas for possible future collaboration.

### I. Nyasa Farmers Visit the Matengo Highlands

Two farmer exchange visits were arranged between July and September 2005, in which 20 people from the Nyasa area visited Kindimba and Kitanda in the

Matengo Highlands. Farmers involved in the exchange programme could be divided into three main categories: village government officials, key informants (elders and youth with special knowledge), and religious leaders.

While in the Matengo villages, the Nyasa farmers learnt how farmers from Kindimba and Kitanda managed to revive and integrate indigenous social organisations with formal village government systems and to pioneer various village development activities (SCSRD & JICA, 2004). They also learnt how the church in Kindimba played a role in bringing village development to the forefront. The need for democratic and transparent village government and active participation of local communities in collaborating with other stakeholders to bring about sustainable rural development was stressed. Visiting farmers also learnt about (a) the importance of, and underlying principle behind, farmer group formation and management; and (b) the attempts of farmer groups and social organisations to act as catalysts in community development activities. Farmers visited various community-initiated development activities, including a hydro mill, tree nurseries, a dairy farm, fish ponds, apiaries, primary and secondary schools, and the church. Most of these projects had originated as a result of local initiatives, and continued management was the task of the local communities through collaboration with other stakeholders. It was eye-opening for the visitors, as they had no such approaches in their home villages. Talks with Kindimba farmers made the visiting Nyasa people reflect on their defunct indigenous social organisation, the *kumbi*.

## II. Matengo Farmers Visit Lake Nyasa Villages

In October and November 2005, Nyasa farmers invited the Matengo farmers from Kindimba and Kitanda to share insights of Matengo experiences and to witness the impact of highland farming activities in the river–lake ecosystem. Fifteen farmers from Kindimba and Kitanda visited the Nyasa villages between October and November 2005 as part of the same exchange programme. During their stay in Lake Nyasa, the Matengo farmers conducted public village meetings that attracted unprecedented attendance. Roughly 300 people participated in one such meeting. Before conducting public meetings, the visitors and their hosts, led by village leaders, elders, and other key persons, fished and visited potential areas for resource assessment, including schools, old *kumbi* spots, churches, rivers, the lake, the Mbamba Bay port, waterfall sites, wetland areas, Mount Livingstone, cultivated fields and reserves, and fallow lands. Critical examination of such resource endowment was necessary to determine possibilities for sustainable intervention and management of such resources. As in the Matengo villages, visitors stayed in host houses where they could continue sharing insights at night. The visitors' experience showed them that the areas along Lake Nyasa had appreciable natural and human potential that, if properly tapped, could play a decisive role in alleviating poverty, managing the environment, and making the place attractive for ecotourism.

During village public meetings, the Matengo elaborated on their experi-

ences participating in research in collaboration with different stakeholders. The Matengo farmers are experienced in contacting and working with researchers and other development stakeholders and have implemented various projects related to community development and environmental management. The effect of mountain degradation on aquatic life and on the livelihood of the people living along Lake Nyasa was debated in detail. The exchange programme pinpointed that careful use of mountain slopes and rejuvenation of degraded land in the mountains was imperative. The Lake Nyasa dwellers asked about relieving their over-dependence on lake products based on their traditional fishing style. Visiting farmers suggested that they develop fishing zones and keep other zones for conservation. The Nyasa's reliance on log canoes was also challenged given this era of declining tree cover. Fishing and fishing gear proved an insurmountable issue for the community and called for further research and lobbying of other rural development catalysts.

Another debated area was the development of paddy and sugarcane cultivation in wetland areas, as well as palm, coconut, cashew nuts, and cassava farming that could have a positive impact in the area. If improved, other crops that could be instrumental in improving peoples' livelihood are groundnuts, bambara nuts, mangoes, and other tropical fruits. The area along Lake Nyasa also has untapped potential for growing vegetables. Thus, with improved transport and infrastructure with the towns of Mbinga and Songea and neighbouring Malawi and Mozambique, the area could realise decisive socioeconomic growth. Indoor husbandry of livestock such as pigs, goats, and cattle was advised to improve animal health and acquire high market values.

Waterfalls such as the Chikalilandonya in Matenje village have flows that are strong enough to run mid- to micro-hydro mills (for cassava and grain milling) and provide a domestic water supply, hence reducing the long walking distance for women to reach the milling machine or to obtain clean and safe drinking water. Monetary savings could also be realised if diesel-propelled mills were replaced with environmentally friendly and cost-effective hydro mills. However, the question of achieving sustainable development along the lakeshore lingered on the ongoing intensive degradation of the Livingstone Mountains, which poses undue threat to the environment and to the livelihood of the people residing along the Lake Nyasa. Participants suggested the need for the active involvement of both communities in future conservation and development initiatives.

The Matengo farmers also insisted on the importance of the formation of farmer groups as a basis for forming strong intra- and inter-partnerships with other stakeholders in rural development. Farmer groups were hailed for making various rural services such as credit facilities, training, and extension more accessible to farmers. Village governments were strongly advised to establish procedures for the monitoring and evaluation of farmer groups. Farmers along Lake Nyasa admitted that they knew little about group formation and group management dynamics and requested more time to become familiar with these concepts.

The vital role of researchers in rural settings was also identified as critical

to the process of achieving sustainable rural development. Some insisted that it was essential to develop purposive collaborations with researchers and other rural development agencies to facilitate discussion of community development issues. The importance of speaking honestly, openly, and without bias when providing information to researchers was also highlighted, as was the importance of farmer exchange programmes aimed at sharing insights and experiences. Participants spoke of the value of strong leadership to mobilise local resources as well available human resources to tap socioecological benefits. Likewise, village government leaders were asked to develop a framework that could facilitate lobbying with local government authorities and other catalysts for rural development.

After participating in these three farmer exchange visits, villagers knew it would be necessary, albeit difficult, to revitalise their indigenous social organisation. They realised that this could be accomplished by modifying the indigenous *kumbi* social organisation along Lake Nyasa as had been done in the Matengo Highlands, where the *sengu* was revitalised in Kindimba and became a key catalyst in village development activities. Recently, *kumbi* have begun to re-emerge as people dispersed by villagisation are attempting to resettle along the lakeshore. However, the current *kumbi* have modified functions, primarily acting as rest areas, kiosks, or food vending places or where people can discuss anything with no necessity of being of cultural functional value. Women also share in the current *kumbi* system; some of them prepare and sell food to those resting in the *kumbi* or engage in casual conversations with men.

The revival of a modified *kumbi* system that caters to modern needs is a painstaking process, but one worth trying. It is necessary to determine how it could work with village development plans that borrow from the experiences of Kindimba in the Matengo Highlands, where the once-defunct *sengu* system was rejuvenated and now plays a decisive role in spearheading community development alongside the village government. It was strongly questioned whether such community development initiatives could evolve within local needs and aspirations based on the morals and values of the community. When I visited Matenje village at the end of November and early December 2005, people had already formed a *kumbi* committee and had started community development projects such as repairing village roads. Three farmer groups were formed in response to the lessons learnt from the Matengo highlanders.

I have discussed the state of the Lake Nyasa environment, its catchments, and the rivers opening into it. I have elaborated on the need to establish farmer exchange visits between mountain and lowland farmers for future collaboration on sustainable resource management. It is very important for farmers to initiate their own activities and for outsiders to respect farmers' ways of doing things. Scientists and other rural development catalysts need to join, encourage, think together with farmers, and act as their messengers to higher authorities. In-depth studies at various levels (worm's eye, bird's eye, and satellite image analysis) would help explain the problem in more detail with an eye toward possible interventions.

## CONCLUSION

In this article, I have discussed the dynamics of the environment along Lake Nyasa and the livelihoods of people living along the lake. I have also elaborated on the potential of various stakeholders to collaborate in the livelihood diversification process and in environmental conservation. The Nyasa people can be categorised as small stakeholders with limited income to acquire most of their basic needs. Their endogenous development depends on the relationship among humans (social organisation, knowledge, skills, and insights), nature (water, land, and ecosystem), and the spiritual realm (rituals, religion, beliefs, norms, and values). However, there is a need to improve their local knowledge systems, livelihood capitals and practices to enhance *in situ* development built out of people's needs and locally controlled development alternatives. Identification of new development avenues, selective use of external resources, exchange and learning between cultures, and capacity building are paramount for realising sustainable endogenous development in this remote area. Networking and strategic partnerships enable mountain and lowland farmers to jointly participate in sustainable use of resources in their respective areas or collectively are vital.

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## NOTES

(1) *Kuombaliza* is a traditional practice among the Nyasa people whereby the fish catch is shared for free with others who have gathered along the shore.
(2) A *kumbi* is a small hut built near the shore in which men meet to discuss various issues within their extended family or community. It is also a dining place for men in which a generalised reciprocity of group eating is a common element. *Mudzi* is a collection of households of the similar ancestor.
(3) I do not know which herbs were collected as *mbatawata* and have no scientific proof as to how the herbs functioned.

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Author's Name and Address: Stephen J. NINDI, *Center for Sustainable Rural Development, Sokoine University, P.O.Box 3035, Morogoro, TANZANIA*
*E-mail: snindi@yahoo.com*